No. IV.—Vol. I.

OF THE

USEFUL CABINET.

APRIL, 1808.

TRISECTION OF ANGLES.

[*Concluded.*]

DEMONSTRATION. Let a be the point where E F intersects D A; then in the triangles E a A, F a A, by construction, E a is equal to F a, and the angle E a A is equal to the angle F a A, and the side a A is common to both angles, therefore (*a*) the *third sides* E A, F A are equal, and the angle E A a is equal to the angle F A a, being opposite to the equal sides E a, F a; but by construction the angle B A D is equal to the angle C A D, and E A a, part of B A D is found equal to F A a part of C A D; therefore (*b*) the angle B A E is equal to the angle C A F. *a* 4. 1*. *b* 3. *Ax.*

In the triangles B g A, E g A, the side B g is equal to the side E g, and the angle B g A equal to the angle E g A, and the side A g is common to both angles; wherefore (*c*) the *third sides* B A, E A are equal; but it is found that the side E A is equal to the side F A, therfore (*d*) B A is equal to F A. Because in the triangles B A E, E A F, the two sides B A, E A of the one are equal to the two sides E A, F A of the other, and their bases B E, E F are equal by construction, therefore (*e*) the angle B A E contained by the two sides of the one is equal to the angle E A F contained by the two sides of the other; but it has been proved that the angle B A E is equal to the angle C A F, and therefore (*f*) the angle E A F is equal to the angle C A F. Wherefore if in any angle &c. Which was to be demonstrated. *c* 4. 1. *d* 1. *Ax.* *e* 8. 1. *f* 1. Ax.

* The Geometrical Elements referred to by the marginal numbers may be found in "Playfair's Geometry" Philadelphia Edition, printed for F. Nichols 1806.

This proposition is clear in its enunciation, and the demonstration is considered to be strictly logical; the hypothesis or assumption of a particular position of a line between the parallel and one of the legs is obviously possible, and very far from implying a contradiction; and indeed a method of actually exhibiting it is offered in page 60, by the *mathematical square*, which is considered as equally correct with any mode of exhibiting diagrams by the help of *other* mathematical instruments.

The assumptions usually admitted, or as they are commonly called the postulates, are *principles borrowed from the Arts*, and if Science is acknowledged as the handmaid of Arts, it becomes the province of Science to seek a logical demonstration of the correctness of any new rule which is proposed in the circle of Arts, even a common carpenter with his square and a marker (*for which he commonly makes use of one leg of his compasses,*) can be taught in half an hour to trisect any angle, with as much correctness as he performs any other rule founded on principles capable of Geometric demonstration.

Altho' at present this assumption seems to rest on necessity, yet for the satisfaction of those who prefer to reason on the properies of figurers which require circles as well as straight lines in their construction, it may perhaps be discovered to be of that class, by a close attention to the diagram in page 63, (*in which however the small letters e and b, should be transposed.*)

But if it should not be found that the fourth proposition is capable of demonstration in a strict geometrical manner; we may still rest in confidence on the settled opinion of so many able writers "that for the purpose of discovering the properties of the figures, we are certainly at liberty to suppose any figure to be constructed, *or any line to be drawn*, the existence of which does not involve an impossibility."

ON CLOCK PENDULUMS.

MESSRS. EDITORS,

TO remedy the effects of heat and cold on the pendulum rod, and to render its vibrations uniform and equal, has long been a desideratum. This has heretofore engaged the attention of the greatest mechanics and philosophers of Europe, whose theories, plans, and contrivances, though brought forward with much confidence, have all failed of success. The true principles, upon which a clock pendulum ought to be constructed, and the mode of applying brass and iron rods to counteract the effects of heat and cold, in order to keep accurate time, seem either not to have been as yet known, or to have been wholly misapprehended in the application. Simplicity of construction, so necessary to obtain this object, is generally the last improvement to be made in any machine ; and is always the last expedient, which mistaken theorists will ever admit, though they may have been long apprised of its advantages.

Without burdening this communication with a description of those ill contrived pendulum rods, loaded with an enormous quantity of brass and iron, and yet designed to remove the effects of heat and cold, some in the form of a gridiron, others constructed with large bars of brass and iron, all of which serve only to increase the evil intended thereby to be removed; I will endeavour to describe the construction of a pendulum perfectly simple, and the manner of combining brass and iron rods, which, if properly executed, will completely counteract the effects of heat and cold on the pendulum.

1st. The pendulum rod must be simply a single rod of good iron wire, well hammered and rendered perfectly straight, and of such a size, in proportion to the weight of the ball, as will prevent its trembling when vibrating. The pendulum spring ought to be about three inches long, made of a wide piece of a watch spring, ground or filed down very thin with the temper in it, and polished and blued. The pendulum ball must be fastened to the rod by a pin through its center. The pendulum must be regulated at the top, by a regulating screw connected with the top of the pendulum spring. This ought always to be the mode of regulation in all pendulums.

2d. One iron and two brass rods of equal lengths, and of the same size of the pendulum rod ; and equal in length to one and an half the length of the pendulum rod from the center of the ball to the actual point of suspension ; must be combined together with the iron rod between the two brass rods. They must be well hammered and made perfectly straight. The two brass

rods [*two* are used only for uniformity] must be screwed at their top ends, about an inch apart, to a firm piece of brass cast for the purpose, which serves for the back-cock, having a horizontal square bar of brass extending three inches from the plate on which the pendulum is suspended. This back-cock with the rods is screwed to the back board of the case directly back of the movement. The brass rods with the iron rod in the middle are fastened together at their lower ends by a cross bar, through which the ends of the rods pass. Upon the top of this iron rod, [which is not fastened at the top as the brass rods are] is screwed a piece of square brass, made for the purpose, extending out three inches horizontally and directly under the back-cock. Through the end of the said piece of brass, thus screwed on the top of the iron rod, this pendulum spring passes. So that by this piece of brass moving up and down on the pendulum spring, as the rods, are effected by heat or cold, the pendulum is shortened or lengthened out exactly according to the dilation or contraction in the pendulum by the same degree of heat or cold. This brass thus moving on the spring, as well as the iron rod, on the top of which it is screwed, is rendered firm and steady by friction rollers, so as not to be in the least moved laterally by the vibrations of the pendulum ; and at the same time to admit the heat and cold to produce their effects on this combination of counteracting rods, without being obstructed by any friction of the metals moving against each other.

Heat dilates or lengthens, and cold contracts or shortens all metals ; but some more than others. From accurate experiments it has been found, that the same degree of heat or cold operating equally upon brass and iron rods of the same size and length will dilate or contract the brass five parts and the iron rod but three parts. Or what is the same, an iron rod of five parts in length, and a brass rod of three parts, and of the same size, will be dilated or contracted by the same degree of heat and cold to the same extent. Here then is an exact rule, by which to proportion the length of brass and iron rods to be combined, so as to have the excess of contraction or dilation in the brass rods completely counteract these effects on the iron.

A pendulum to beat seconds is 39 $\frac{2}{10}$ inches in length from the center of the ball to the point of suspention. Once and an half of this length is 58 $\frac{8}{10}$ inches, which is the length of the combined rods. Now 58 $\frac{8}{10}$, the length of the iron rod combined with the brass rods, being added to 39 $\frac{2}{10}$ inches, the length of the pendulum, make 98 inches, which is the whole length of iron rod to be acted upon by heat and cold.

Therefore, 98 inches are the five parts of iron, and 58 $\frac{8}{10}$ inches being three fifths of 98, will be the length of the brass rods; which when combined so as to have the effects of heat and cold on the brass rods counteract the same on the iron rod, the pendulum will not be in the least effected by heat and cold.

Whatever is the length of the pendulum, the rule is, that the combined rods, for counteracting the effects of heat and cold, be in length equal to once and an half the length of the pendulum. The additional length of the pendulum spring and regulating screw, which is above the operating point of suspention, and which is subject in common with the whole pendulum rod to the effects of heat and cold, requires strict attention in making exact allowances to the length of the combined rods, for this additional length of spring and screw, which is necessary for the purpose of regulation.

Theory here is reduced to practice in the most simple manner. And actual experiment has proved what is above laid down to be as correct in practice as in principle. If the work is executed according to the foregoing rules and directions, the effects of heat and cold on the pendulum rod will be completely counteracted, and the pendulum left in its most simple state.

The effects of the density and rarity of the air are next to be considered. These occasion irregularities in the vibrations of the pendulum, which can never be wholly remedied. The resistance of the air to the motion of the pendulum varies in proportion to its density or rarity. The greater the density of the air the greater will be the resistance, and the shorter will be the motion of the pendulum and the quicker its vibrations; and vice versa with the rarity of the air. The body, which will move through the air with the least resistance, is that which contains the largest quantity of matter within the smallest quantity of surface. This will be in the form of a perfect globe. And the resistance, with which globes of different sizes meet in the air is in proportion to the squares of their diameters. The larger the globe the greater the quantity of matter it will contain in proportion to its surface. Therefore, a pendulum ball ought to be a perfect globe of solid lead, and as large as possible in proportion to the size of the movement. The proper proportion of a pendulum ball, if the movement is rightly constructed, is to have it contain the same number of pounds as the weight, which carries the time piece. Consequently a ball that weighs twelve pounds, will meet with much less resistance from the air, than one of half that weight; and of course the vibrations of the pendulum will not be so much effected by the density and rarity of the air, when the pendulum ball is a perfect globe

and as heavy as can be kept in motion by the movement. In addition to this, the case ought to be made so perfectly close, as not to admit any current of air or dust to disturb the vibrations of the pendulum.

Another source of irregularity in the vibrations of the pendulum arises from external motions given to the clock by the trembling of the floor, on which it stands ; and by the shaking of the house occasioned by wind or thunder. These evils may be principally avoided by fastening the clock to the walls of the house, which are the least liable to be shaken, so that the case may be entirely free from the floor.

The last source of irregularity in the vibrations of the pendulum, which I shall notice in order to point out a remedy, is that which arises from the unsteady motion communicated to the pendulum by the clock movement. If the motive power given by the crown wheel to the pendulum is not exactly equal at every beat, and at every intermediate space of time, it will be impossible, even if all other causes of irregularity are removed, for that pendulum to preserve the same degree of motion, and perform its vibrations in equal times. The attainment of this object depends upon correct theory, and perfection in practice. From these circumstances it will be difficult to obtain even an approximating remedy, without first exploding many of those habitual errors, which being handed down by mistaken theorists for several generations have become, in the opinion of modern mechanics, "*first principles*," and which they believe to be true and infallible, although their own experience has a thousand times proved them to be false and erroneous. The difficulty is, that the man of science, who is well versed in natural philosophy, not being a mechanic, is unable to discover the immense distance between mere philosophical theory and that theory, which is found correct in practice. And the mechanic not being a philosopher or man of science, is confounded at the errors of that theory, which he endeavours in vain to reduce to practice, and which he still believes to be correct merely because a philosophical theorist "has told him so."

The remedy of those defects, here alluded to, depends upon a mechanical proportion in the clock movement—upon the removal of friction to the greatest practicable degree—upon the gaining more power in the movement and yet to have it go with a comparatively light weight—and upon an escapement in the pallets and crown wheel, which shall so operate as to be seven eighths of the time communicating an equal, uniform, and gentle motion to the pendulum. The consideration of these parts will embrace every article in the movement.

First. The exact proportion of the wheels, pinions, and pivots in a movement is to have them correspond in size, strength, and magnitude to the force applied to them. This proportion ought to be observed as far as practicable with respect to the pivots, size and strength of the wheels, and the fineness of their teeth.

Second. The barrel should be as large as the main wheel will admit, and the cord wound on the side of it next to the pinion it drives, the advantage of which will be that of lessening the friction on the pivots of the barrel, by having a light weight, and by having three fourths of that weight wholly suspended on the pinion, and but one fourth on the said pivots. The position of the wheels and pinions ought to be in this manner, so that one half of the force applied to turn them may be suspended between the teeth of the wheels and pinions, and the pivots freed from one half of the friction, to which they are generally subjected—To illustrate this position—Admitting a wheel to take hold of a pinion on one side, and a wheel on that pinion to take hold of another on the side opposite to the first wheel. In this case twice the force applied to turn that pinion operates on its pivots. But if the second wheel takes hold of a pinion on the same side with the first wheel, a part of the force applied to turn it is taken off from the pivots and suspended between the teeth of the two wheels and pinions; and consequently the friction on the pivots will be lessened. The pivots of wheels and pinions thus put together, operate as fulcrums or props of leavers of the second order in mechanics. A leaver of this kind has the weight or thing to be raised between the fulcrum or prop and the hand that lifts it, so that but a part of the thing to be raised is suspended by the leaver on the prop, and the other part on the leaver in the hand that lifts it.

A leaver of the first kind is when the prop or fulcrum is between the thing to be raised and the hand that bears down the end of the leaver. Here the prop has to support not only the whole weight of the thing to be raised, but as much more weight on the other end of the leaver as is necessary to balance it. The same will be the case with pivots when the first wheel takes hold of a pinion on the side opposite to that, where the second wheel takes hold of another pinion; and consequently there will be twice the friction on those pivots.

Strict attention ought to be paid to these principles in drawing the calliper, as it is called, of a movement, so as to free the pivots from that burdensome friction, which is so pernicious in time pieces. In addition to the above rules for lessening the

friction of the pivots, another is, to have the ends of those pivots turned to a point and to run against hardened steel well polished, so as to prevent their shoulders from rubbing against the plates of the movement.

3d. By increasing the number of teeth in the wheels and pinions much power is obtained. For with high numbers the motion communicated by a wheel to a pinion is direct. The number of teeth in the wheels and pinions therefore ought to be so high that the tooth of the wheel may take hold of the leaf of the pinion when it points to the center of it. The following I consider a good calculation for a time keeper, viz.

Barrel wheel,	number of teeth	288	pinion	48=6	turns.
Intermediate wheel,	do.	do. 192	do.	48=4	do.
Center wheel,	do.	do. 256	do.	32=8	do.
Second wheel,	do.	do. 225	do.	30=7½	do.
Crown wheel,	do.	do. 30.	Pendulum	39 $\frac{2}{10}$	inch.

The barrel turns once round in 24 hours.

An important advantage is obtained in this calculation, which cannot be had in any other upon principles of practicable proportion, viz. the number of leaves in the crown wheel pinion is the same with the teeth in the crown wheel.

This is a circumstance absolutely necessary to insure the communication of an exact and equal motion to the pendulum at every beat of the crown wheel.

The pinions in this calculation should be cut on an engine, as the teeth to watch wheels are. In consequence of their size it will be necessary to make the pinion heads seperate and drive them on to the arbers after they are finished.

A time keeper made upon the above calculation and proportions will go with one fourth of the weight necessary in common clocks, and yet communicate more power to the pendulum. The great evil attending all machinery is friction. And perhaps the only improvement that now remains to be made in clock work, is to calculate and proportion the movement, and to execute the work, by means of correct engines, to such a degree of perfection, as to remove comparatively all the friction.

4th. The escapement of a time keeper with the common pendulum is of the greatest importance, both in theory and practice. For upon this part, after the perfection of the other parts, finally depends the communication of an exact and uniform motion to the pendulum, so necessary for acurate time.

AMERICAN.

(To be Continued.)

ON PAPER.

AS the scarcity of paper in this country may be anticipated, from the increasing demand, and from the interruption of European commerce ; it may be an object of some importance to find some new substance, convertible to that use.

In Persia they make a paper of bamboo, which is very delicate to write on, and takes the best impressions of elegant engravings.

" In China paper is made of bamboo. The straw of rice and other grain, the bark of the mulberry tree, the cotton shrub, hemp, nettles, and various other plants and materials are employed in the paper manufactories of China ; where sheets are prepared of such dimensions that a single one may be had to cover the whole side of a moderate sized room.

The fine sort for writing upon, has a surface as smooth as vellum, and is washed with a solution of allum, to prevent the ink from sinking.

Many old persons and children earn a livelihood by washing the ink from written paper, which, being afterwards beaten and boiled to a paste, is re-manufactured into new sheets ; and the ink is also separated from the water, and preserved for future use."

Extracted from Barrow's Travels in China, an American edition, which is worthy the perusal of all persons who are curious to know the arts of prudence and industry necessary for the support of man, in a country so crouded with inhabitants.

IMPROVED FIELD ARTILLERY.

WARS will continue on the earth, while vanity, avarice and ambition are inherent to the nature of man, and affect nations as well as individuals ; a careful attention to military affairs will therefore be a prominent duty of all Independent Governments. However the government and people of any nation may prefer peace and honest commerce with all the world, yet it cannot be expected, in an age when war is so fashionable, that a nation can long support its Independence, without being constantly prepared to bring its physical force into immediate action, ac-

companied with the best improved weapons of defence, for the support of its rights and dignity, for repelling assaults and resisting invasion.

The United States have established their character as peaceably disposed to all nations, which has been sufficiently illustrated since the adoption of the federal constitution. With the extent of uncultivated land they now possess, it is probable they will not for a century to come, exchange their peaceable character for a thirst of conquest or a disposition to offensive warfare.

If these observations are just, in a military point of view, it may perhaps be sufficient for them to have their inland frontiers guarded by small strong posts, judiciously located, well appointed and supplied, to which as rallying points the force of the country may collect, if its peace should be threatened by any hostile neighbour. But from this quarter no serious danger can be apprehended while the powerful nations of Europe whose colonies are our neighbours are engaged in the present war.

It is on the seaboard where our attention is most required in defensive preparations. As all the belligerent nations are superior in naval power to America, and as some of them may wish to drive us from our standing of neutrality, and obtain from us advantages denied to their enemies; we may with upright intentions excite the resentment of some one, possessing naval force superior to what we can oppose to it.

The first defensive measure which presents itself to the mind, as of primary importance, is to make preparations for protecting our principal towns and cities from tribute, pillage, and conflagration; by erecting forts, on suitable positions in and near them, to be supplied with proper ordnance, ready to receive the force of the nation, at the momentary notice of an approaching foe.

The second is to occupy such posts as will make the *approach* more dangerous to an enemy.

The third is to secure with forts and heavy ordnance the positions which command such outer harbours and road-steads, as would serve for anchorage for enemies' ships, from whence they might make excursions to the interruption of the whole commerce of our coast.

These general observations may be sufficient; the particular locations must be left to judicious engineers, the principles being truly American will not be controverted. The first proposed defensive measure is at all times important, and the expense would

be much less than might be apprehended, the lines being properly constructed at first, and guarded by a few centinels from careless or mischievous injury, will require but little annual expence of labour to keep them in good order; the guns and even the platforms and sleepers may be housed under cheap sheds constructed for the purpose, and thereby preserved twice the length of time they can possibly be when exposed to the varieties of the weather, a very little time would plant the platforms at the embrazures, and place the guns at their posts.

There are now lying in an unprepared state in and near the town of Boston a sufficient number of Cannon which, if properly mounted and distributed in suitable breastworks would accomplish the first proposed measure, of effectual security to the town against insulting menace.

If these hints are considered as proper and necessary, they will no doubt be duly attended to by those to whose duty it may appertain—in addition to these preparatory measures of defence maybe added, such a distribution of Field artillery as may be expeditiously moved to any required post; these for the seaboard should be of the larger kind, such as medium 18 and 12 pounders brass, 8 and 10 inch Howitzers &c. Light and medium 6 pounders are more suitable for the interiour—and frontiers. Small field pieces are justly getting out of repute, and it is probable will soon be entirely laid aside; by new improvements in construction of travelling carriages, invented by Capt. David Cobb of Boston, two able horses are sufficient for a 6 pound brass field piece; if placed by the side of each other with a single pole, and the limbers not incumbered with extra ammunition boxes, they can go at the rate usually travelled by other wheel carriages drawn by two horses.

The general advantages of Cobb's improvements are that the horses going two or three abreast, can draw more than when strung out in a line. That the limber wheels being increased in size renders the draft easier; that two pair of horses will carry the same piece say a medium 12 pounder with a quicker pace, and more ease, than five strung in line; that the new mode of connecting the trail and limbers relieves the gun wheels, and at the same time does not force the harness against the belly of the fill horse, but leaves the shafts to bear on the horses back, or the pole by the yoke and straps to bear on the necks of the horses, as usually harnassed by the back-country waggonners, or by a pole over the saddles as a curricle is commonly harnessed.

The turnpike and other smooth roads will admit of three horses going abreast, but generally the state of roads in this country is such that it will be most eligible to harness the horses in pairs; the plate here represented is drawn on the plan of three horses abreast.

Reference to the Plate.

IN Fig. 1. T represents the single trail of the field-piece. A. is a large iron bolt passing through the bed and the end of the single trail, and serves as a joint pin in elevating or depressing the piece.

B is another and similar iron bolt passing through the bed and the trail. When the piece requires the greatest degree of depression this last mentioned bolt is taken out, and, after the bed is thrown up by the screw D to the proper place, is put into the hole C.

F is a large iron hook fixed into the back part of the center of the forward axletree, on which the trail is limbered, or hooked. G is a projection on the trail with a bolt hole through it made to fit the cheeks of the bed at B. When the trail is to be shortened by shifting it back, so that the end of the trail at A is hooked to the rear axletree, the bolt B then goes through in the trail at G.

By this alteration the distance between the gun and limber is diminished, the consequence of which is, that the horses on a march will draw the field piece with much greater ease.

Fig. 2. represents the shafts of the limber with a long swingletree calculated for three horses to draw abreat. The advantage of this is, that three horses abreast will be able to draw as much as four harnessed in the old way.

From this improvement in field-piece carriages several important advantages are obtained, which cannot be had in those of the present construction.

First. With a single trail thus constructed one man will be able to limber a six pounder with more ease than two can those of the old construction.

Second. The top part of the forward axletree is obtained, and may be used for carrying a large ammunition box, and thereby the gun wheels will be released from the additional weight of cartridges and balls.

Third. The piece may be fired without unlimbering, and without injury to the horses, as the weight of balls &c. in the box on the forward axletree will prevent the recoil of the piece in a great degree.

COBB's FIELD PIECE.

FIG. 2.

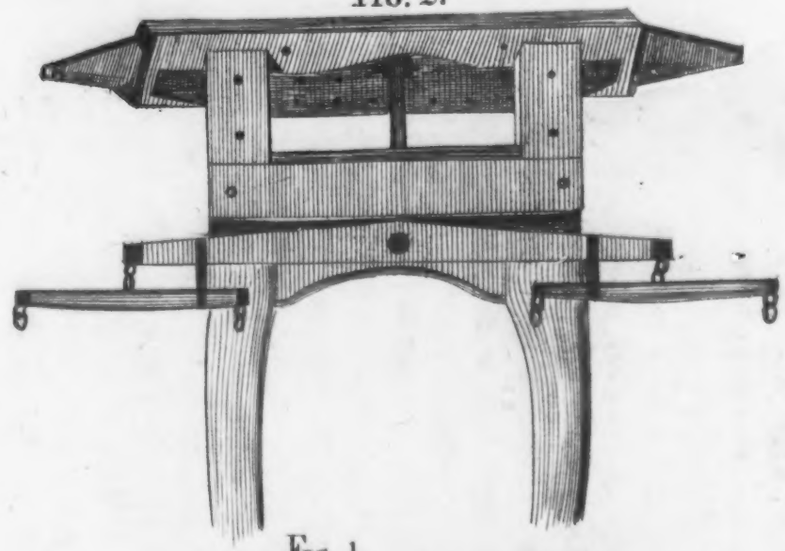
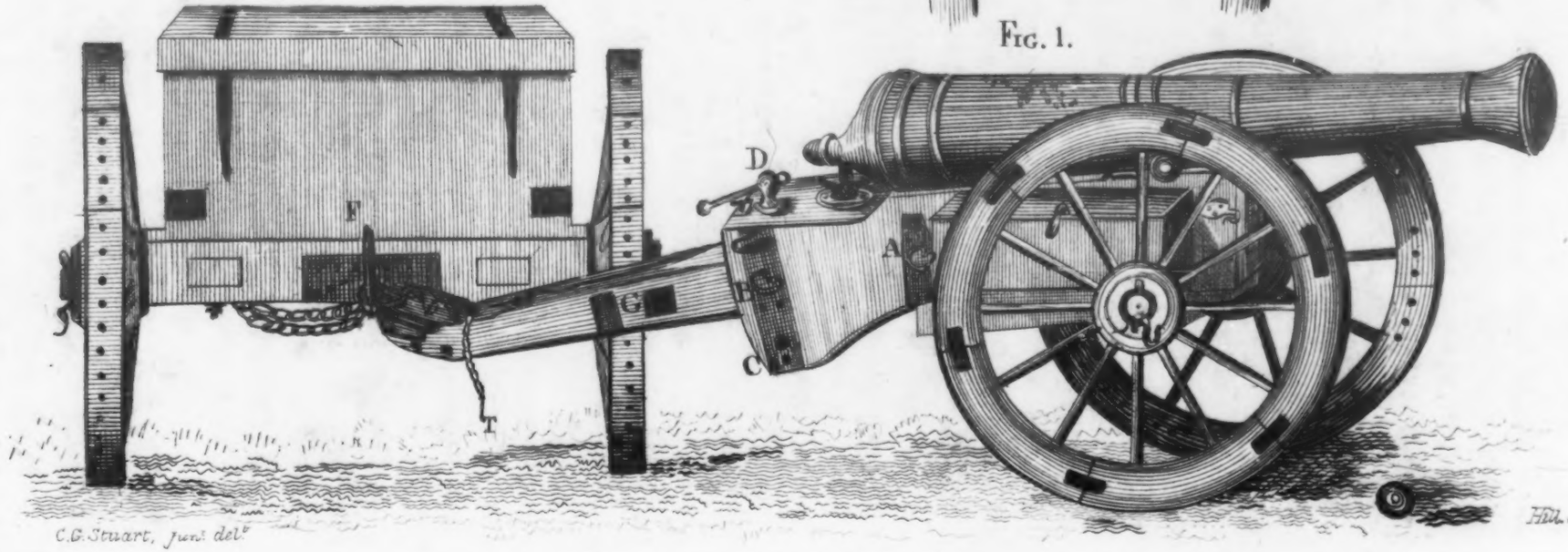


FIG. 1.



C.G. Stuart, junr. delt.

Hill. sc.

Fourth. The piece is capable of a greater degree of elevation and depression than the present constructed artillery.

Fifth. The forward wheels may be of the same size of the gun wheels, the advantage of which will be, that if one of the gun wheels should be injured so as not to be of sufficient strength to carry the gun, one of the forward wheels may be shifted on to the gun axletree and the piece thereby be prevented from falling into the enemies hands.

Sixth. Another advantage in this improvement is, that of shortening the line of march of an army, by shifting the single trail back to the rear axletree, and by having two or three horses abreast, as the weight of the gun and ammunition may require, and to which the limbers may be fitted.

In addition to the above advantages, the expence of constructing field pieces upon this improved plan is no more than that of the present construction, and they are equally strong and secure.

For this important improvement, in the carriages of field-pieces the government of the United States have granted a patent to the inventor.

ORIGIN OF ARTS.

(Continued from page 71.)

TO Paulinus bishop of Nola in Italy, who flourished about the year 400 A. C. is attributed the invention of bells. The particular use, to which the inventor first designed them, is left to conjecture. About two centuries after, they were used in churches, as they are at the present day. The various purposes which they are now made to answer in society, clearly illustrate the importance of the invention.—While the sound of them frequently calls us to the performance of duties both civil and religious, let us not repay our reverend benefactor, *the inventor*, with ingratitude, by neglecting their timely and harmonious admonitions!

Of the invention or discovery of glass, an article now of the first importance, history gives no particular account. The art of making it was first introduced into England from France by Benault a monk, in the year 664. But so little were the conveniences to be derived from its use realized, that even in England it was not used for windows in private houses until A. D. 1180, 516 years after its introduction. A singular instance of

the *prejudice* of mankind *against* the *adoption of inventions and discoveries*, which, when improved, and properly applied, are capable of administering so much to the comforts and conveniences of civil life! The manufacture of this article is now carried to the greatest perfection, and forms an important item in commercial dealing. Those gentlemen, who have established manufactures of it in this country, are entitled to much credit, and deserving of the patronage of their countrymen.

The discovery of making Sugar from what is now called "sugar cane" belongs to the ancient Asiatic. The cane was first brought from India on this side of the Ganges, into Sicily about A. D. 625, and from thence transferred to the West India Islands. The art of refining sugar was discovered in 1148 by a Venetian, for which invention his country gave him 100,000 crowns. The English have since improved the art of refining as well as of making it. As an article of food both salutary and nourishing, it has become, from the long and habitual use, which all classes of people have made of it, one of the important *necessaries* of life. The sugar made from the juice of the maple tree, in the months of March and April, is next in quality to that made from sugar cane. This is an American discovery, and is of great value to people living in the interior part of the country, where they cannot obtain imported sugars but at a very great price.

The Figures in arithmetic, viz, 0 1 2 3 4 5 6 7 8 9 were probably invented in Arabia, from whence they were brought into Europe by the Saracens A. D. 991. The simplicity of these figures for mathematical purposes in comparison with the letters of the Alphabet, which before were used in computation, renders the invention of them of sufficient importance to be ranked among the lasting and valuable monuments of inventive genius.

The discovery of making Paper of cotton is supposed to have been made in Europe about the year 1000 A. C. Before this invention, parchment, made of Sheep-Skins, was used as a substitute in deeds and other writings requiring durability. This was the effct of necessity "the mother of invention". The *Papyrus* supposed to have been invented by the Egyptians several centuries before the Christian era was made of a kind of dog-grass or flag, and undoubtedly the first manufactured matter for writing upon, and from which the name of paper is derived. Ptolemy King of Egypt prohibited the exportation of this article, in order to prevent other nations from making a library as extensive and valuable as that of Alexandria. The conseqence of which was, that Attalus King of Pergamus in Asia Minor, who flourished

B. C. 150, and who wished to rival Ptolemy in the collection of books invented parchment made of sheep skins, which was found to be far superiour to the *Papyrus* both as it respects durability and the ease of writing.—

These two articles were used for books and other writings until the invention of paper, particularly that made of linen rags in the year 1170. Since which time the making of paper from rags of various kinds and qualities has been carried to a very geat degree of perfection in Europe and in America. Paper is now one of the staple articles in commerce. The invention of printing (of which hereafter,) the commodities of an extended and almost universal commerce, the general diffusion of knowledge, and the present mode of warfare, annually consume immense quanties of this article. As it is made of materials which before were of little or no value, and furnishes the civilized world with so many conveniencies, it may justly be considered a valuable discovery.

According to history Roger Bacon of Oxford in England invented Magnifying-glasses about the year A. C. 1252. This discovery paved the way for others of great importance. The application of them in the form of spectacles to assist the eyes of the aged, though deserving of much credit, was a natural consequence. By some this is attributed to Alexander Spina a spanish monk, who flourished in 1285. By others, to Roger Bacon not far from this time. Be this as it may, so excellent and useful an invention as that of spectacles will ever be considered valuable, especially by those whose age require their assistance. For at the time of life when men begin to have dim eyes, their judgement and wisdom are generally in the highest maturity. And the assistance of glasses enables them to be much longer useful to society and comfortable to themselves.

As a consequence of this invention of magnifying glasses is that of the telescope, which is ascribed to Janson a Dutchman, who flour shed in 1590 as an excellent mechanic. The English have improved this instrument to a degree of perfection really astonishing. By the telescope, the knowledge of astronomy is perfected to such a degree as to afford great assistance to navigation, and consequently to commence.

The construction of the microscope, resulting from the same principles, was invented in Naples in the year 1621. This instrument magnifies the smallest objects, so as to be distincly viewed. Whole volumes would scarcely contain descriptions of its wondrous and amazing discoveries.

To the above mentioned Roger Bacon is attributed the inven-

tion of Pulvis fulminans, or Thunder powder, and *Gunpowder*, in the year 1280. From this period may be dated a new era in the art of war. This in connection with the other two great and important inventions, the mariner's compass and printing, have totally changed the face of the world and given that power, wealth, knowledge, and happiness, to mankind, which before never entered into the human imagination.

Pulvis fulminans or thunder powder is made by dissolving silver or quicksilver in aqua fortis and precipitating the solution with spirits of wine. The powder is then to be washed, and dried, and carefully put up in a vial, when it is fit for use. Great caution is necessary in the management of this most powerful of all chymical preparations. If properly made it will explode with a degree of heat not much above blood heat. Its effects are dreadful when even a small quantity of it is exploded. Ten grains of it will make a report as loud as a common gun. Its tendency to take fire, even by friction, is so great, that a grain of it being put upon a cold anvil will explode by striking the anvil with a hammer. It is of no real use, except for the illustration of certain principles in chymistry, in order to make further discoveries in that noble and most useful art.

The use of gunpowder is now necessary to the very existence of national powers. Although from the cannon's mouth it deals destruction to the human race, yet it is a real blessing to mankind—It has changed the mode of war, and enabled the weak man to meet the stoutest champion upon equal ground. It renders war ten times more expensive, and obliges nations, who have the folly to carry it on, to have recourse to industry, manufactures, commerce, and to the arts and sciences in order to be enabled to support the expences of it, and to manage its operations with success. It renders war less sanguinary, because the artificial power it puts into the hands of a skilful commander enables him to conquer more by policy than by slaughter.

The ingredients of gunpowder are saltpetre, charcoal, and sulphur. The proportion of these are 16 oz. of saltpetre; 3 oz. of charcoal; and 1 oz. of sulphur. Some deviations from this rule may be necessary, when the quality of the materials differ in goodness. The French rule is 12 oz. saltpetre; 2 oz. charcoal; and 2 oz. sulphur. The following rule, taken, from an English publication, and established by experiment, may be found useful, viz.

In the manufacture of gunpowder, after the ingredients have been properly refined, it is usual, in order to determine the strength and quality of them, to begin with 3lbs. of saltpetre

well mixed with 9 oz. charcoal. This will explode without sulphur. Then increase the quantum of charcoal till the most forcible combination of saltpetre and charcoal is discovered, which will commonly happen when the proportion is from 12 oz. to 16 oz. of charcoal to 3lbs. of saltpetre. To this process add sulphur, beginning with $\frac{1}{2}$ an oz. till the strongest explosion is found; which will be when the quantity of sulphur, to the above process, is from 2 $\frac{3}{4}$ to 3 $\frac{1}{4}$ oz. Diminish then the quantity of charcoal, till the composition no longer gains in strength. This will commonly happen when the proportion of the three materials stands as follows, viz. saltpetre 3 lbs; charcoal $8\frac{1}{2}$ to $9\frac{1}{2}$ oz; sulphur 2 $\frac{3}{4}$ to 3 $\frac{1}{4}$ oz. or nearly thus; saltpetre 16 oz; charcoal 3 oz; sulphur 1 oz.

The basis of gunpowder is saltpetre, which ought to be well refined. Charcoal made from dog-wood and alder when green the bark being first taken off, and well charred is considered the best; because these are found to contain the greatest quantity of fixed salts, and therefore will inflame with rapidity and great vehemence. Great attention ought to be paid to the purity of sulphur. On this agent depends that instantaneous inflamation, to which charcoal contributes intense fire, and saltpetre its astonishing elasticity and expansion.

In the *parade of war*, where noise only is required, the salt of tartar may be introduced, as an auxilliary in the composition of gunpowder, which will increase the report astonishingly, but is noxious to strength and durability.

A natural consequence of the invention of gunpowder is that of cannon and firearms. In the year 1340, Swartz a German monk of Cologne first suggested gunpowder as useful for warlike purposes. In consequence of which Edward III. king of England had four pieces of cannon made of wrought iron, which gave him the victory over Phillip the French king at Cressy in Picardy in the year 1346, 66 years after the first discovery by Roger Bacon of the effects produced by gunpowder. Hand guns, as they were called, were first introduced in 1521. These were discharged by match locks. Brass cannon were first cast by the English in 1535, and iron cannon in 1547. Since which time they have carried the manufacture of these engines of destruction to the greatest perfection.

Small arms with locks to strike fire by means of a flint and steel is a most excellent and convenient improvement, the precise time of which invention is not known. With these weapons as now improved the correct marksman, though at a distance, becomes a most formidable foe.

Rifle guns are a modern improvement. These differ from common guns, by having their bores, or the inside of their barrels *rifled* as it is called, with a number of spiral grooves, which are cut the whole length of the barrel. The effect produced by this contrivance is, that the ball, when shot, turns round, the axis of which motion points directly to the object aimed at, and prevents that deviation, to which balls shot by common guns are always liable. A hundred of these guns, properly and faithfully made, in the hands of good marksmen are more formidable than a thousand others.

Under this head it may not be improper to subjoin several rules containing the principles and correct proportions, by which gunsmiths ought to be guided in making rifles. In the first place, the barrel ought to be made of good, fine tough iron, soundly welded together, and of sufficient stiffness. Secondly, the bore ought to be exactly of the same bigness at every part of the barrel, perfectly straight and smooth; and the outside trimmed off so as to correspond in evenness with the inside. The size of the bore and the length of the barrel is left, by the gunsmith, too often to the fancy of the customer, without any regard to principles of proportion; the consequence of which is, that but few rifles are found, though ever so well made in other respects, which are fit for use. The notion of having small bores to save ammunition is very erroneous. The larger the ball the less resistance it will meet in the air, and the truer it will go. Taking then a convenient size upon principles of proportion, the bore of a rifle ought to be at least large enough to carry balls twenty four to the pound, and the length of the barrel three feet and six inches. If it carries an ounce ball, the length should be about three feet and eight inches. The latter has the preference, being more sure of the mark, and will carry to a much greater distance.

Thirdly. The rifle, or spiral grooves, five in number, ought to be cut deep, (much deeper than they are at present) and so wide as to take out exactly half the inside surface of the bore. The spirality of these grooves must be perfectly true, and have one turn in three feet. A rifle ball driven with a proper charge of good powder moves at the rate of about 1200 feet in a second of time, which is a little faster than the rate at which sound moves, being 1142 feet per second. Now if it be true, as is supposed, that one third of the charge of powder is exerted in giving the rifle ball this turn or rotary motion, and the other two thirds to drive the ball forward, then the above spirality of the rifle or grooves turning once in three feet, will be correct.

Because then the ball will turn round 400 times in a second, which is one third of 1200, the number of feet it is driven in a second. This proportion is founded upon principles of analogy, and corroborated by experiment. For it has been found, that a ball of the same size shot from a smooth bore gun of equal length and with an equal charge of powder, is driven with a third more force than that of a rifle ball. This cannot be accounted for, unless it is admitted, that one third of the charge of powder in a rifle is exerted in giving this rotary motion to the ball.

The next thing to be considered is the lock. This should be so small and limber as not to shake the gun when it is fired.—And it should be so easy to be snapped, that the least touch of the finger may effect this without moving the barrel of the gun out of the line of direction. To obtain this advantage it will be necessary to have, what is called, a fly fixed on the tumbler of the lock to prevent it from catching upon the *half-cock*, when snapped.

With respect to the use of the rifle gun, some observations may be of service to those, who may wish to become marksmen.

The rifle ought to be spunged clean and dry every time it is discharged. A small wad of dry flax tow ought to be put down after the powder, in order to prevent the dampness of the tallowed patch on the ball from effecting the powder. The ball with a small patch of brown Holland cloth tallowed on the outside should be carefully put down to the charge of powder.

To be a good marksman, it is absolutely necessary to practise shooting at *arm's end* as it is called, that is, without *resting* the gun upon any thing but the hand ; when a person has once acquired the art of shooting correctly at *arm's end*, it may be safely affirmed, that he cannot make half so good shots if he were obliged to *rest*. Instead of wooden gun-sticks, large steel ones ought to be used with a piece of round brass fastened on the ends and fitted to the bore of the rifle ; the end of this brass should be hollowed so as to fit the ball.

In the manufacturing of rifles, gunsmiths will find much advantage by following the foregoing rules and proportions, which may undoubtedly be improved by further experiments. As to the machinery to cut the rifle or spiral grooves, the greatest attention ought to be paid to have the spirality perfectly true. As few gunsmiths make rifles in America, perhaps it may be acceptable here to add a description of a machine for that purpose, which will cut the grooves with *the most perfect spirality*.

A small carriage (similar to a sawmill carriage) about two feet wide and four feet long, must be made to move in angular grooves on a horizontal platform. Of the same length of this carriage is a roller about six inches in diameter with steel centers in the ends, which are fitted into the carriage so as to turn with ease. This roller should be made of seasoned straight grain maple, or other suitable wood, turned exactly of the same size at every part of it. Upon this roller measure off three feet. Then with a wide chissel made for the purpose, and properly fixed into the platform with the edge set in an oblique manner against the roller, move the carriage forward. If this chissel makes the roller turn once round when it is moved exactly three feet forward, continue the motion of the carriage, until the chissel cuts the spiral groove of sufficient depth on the roller to have it turn with security. But if this should not be the case, alter the obliquity of the chissel until it produces a mark or spiral line, which shall go exactly once round on the roller in the distance of three feet. When a correct spiral groove is once obtained on this roller, the other parts of the machine will be found too simple to require a description. To prevent the roller from springing and to render it light, a large hole may be bored through it lengthwise. Great care must be taken to have this roller perfectly straight. The rod, which goes in the barrel to cut the rifle, is fixed into the end of one of the steel centers, upon which the roller turns.

With a rifling machine constructed upon this plan, the grooves in the barrel may be cut with the most perfect spirality, upon which the goodness of a rifle gun depends.

(To be continued)

To the Editors of the Useful Cabinet

GENTLEMEN,

TO aid inventive genius in honorable pursuits, and to prevent a misapplication of it to things not attainable, or which have been already attained are considered as being among the objects of your association ; it is submitted to your candour to communicate to the public the following Extracts from a quarto vol. of Franklin's works, published in London by F. Newbury in the year 1769, the subject is commenced in page 284.— Your compliance with the above will gratify the public, and oblige

A READER.

An account of the new-invented Pennsylvanian FIRE-PLACES: *Wherein their construction and manner of operation is particularly explained; their advantages above every other method of warming rooms demonstrated; and all objections that have been raised against the use of them, answered and obviated. With directions for putting them up, and for using them to the best advantage.* By B. F. *first printed at* Philad. *in* 1745.

AS so much of the comfort and convenſiency of our lives, for so great a part of the year, depends on the article of *fire*; since fuel is become so expensive, and (as the country is more cleared and settled) will of course grow scarcer and dearer, any new proposal for saving the wood, and for lessening the charge, and augmenting the benefit of fire, by some particular method of making and managing it, may at least be thought worth consideration.

The new FIRE-PLACES are a late invention to that purpose, of which this paper is intended to give a particular account.

That the reader may the better judge whether this method of managing fire has any advantage over those heretofore in use, it may be proper to consider both the old and new methods seperately and particularly, and afterwards make the comparison.

A fire being made in any chimney, the air over the fire is rarified by the heat, becomes lighter, and therefore immediately rises in the funnel, and goes out; the other air in the room (flowing towards the chimney) supplies its place, is rarified in its turn, and rises likewise; the place of the air thus carried out of the room, is supplied by fresh air coming in through the doors and windows, or, if they be shut, through every crevice with violence, as may be seen by holding a candle to a key-hole: if the room be so tight as that all the crevices together will not supply so much air as is continually carried off, then, in a little time, the current up the funnel must flag, and being no longer driven up, the smoke must come into the room.

1. Fire, (*i. e.* common fire) throws out light, heat, and smoke (or fume.) The two first move in right lines, and with great swiftness, the latter is but just seperated from the fuel, and then moves only as it is carried by the stream of rarified air: and without a continual accession and recession of air, to carry off the smoaky fumes, they would remain crouded about the fire, and stifle it.

2. Heat may be seperated from the smoke as well as from the light, by means of a plate of iron, which will suffer heat to pass through it without the others.

3. Fire sends out its rays of heat, as well as rays of light, equally every way; but the greatest sensible heat is over the fire, where there is, besides the rays of heat shot upwards, a continual rising stream of hot air, heated by the rays shot round on every side.

These things being understood, we proceed to consider the Fire-places heretofore in use, *viz.*

1. The large open fire-places used in the days of our fathers, and still generally in the country, and in kitchens.

2. The newer-fashioned fire-places, with low breasts and narrow hearths.

3. Fire-places with hollow backs, hearths and jambs of iron, (described by *M. Gauger* in his tract entitled, *La Mechanique de Feu*) for warming the air as it comes into the room.

4. The *Holland* stoves, with iron doors opening into the room.

5. The *German* stoves, which have no opening in the room where they are used, but the fire is put in from some other room, or from without.

1. The first of these methods has generally the conveniency of two warm seats, one in each corner; but they are sometimes too hot to abide in, and, at other times, incommoded with the smoke. Their inconveniencies are, that they almost always smoke, if the door be not left open; which occasions what is called a strong draft to the chimney, without which strong draft, the smoke would come out of some part or other of so large an opening, so that the door can seldom be shut. A moderate quantity of wood on the fire, in so large a hearth, seems but little; and, in so strong and cold a draught, warms but little: so that people are continually laying on more. In short 'tis next to impossible to warm a room with such fire-place: and I suppose our ancestors never thought of warming rooms to sit in; all they purposed was, to have a place to make a fire in, by which they might warm themselves when cold.

2. Most of these old-fashioned chimneys in towns and cities, have been, of late years, reduced to second sort mentioned, by building jambs within them, narrowing the hearth, and making a low arch or breast.

This improvement, however, by small openings and low breasts, has been made in our days; and success in the first experiments has brought it into general use in cities, so that almost all new chimnies are now made of that sort, and much fewer bricks will make a stack of chimneys now than formerly. An improvement

so lately made, may give us room to believe, that still farther improvements may be found to remedy the inconveniencies yet remaining. For these new chimneys, though they keep rooms generally free from smoke, and the opening being contracted, will allow the door to be shut, yet the funnel still requiring a considerable quantity of air, it rushes in at every crevice so strongly, as to make a continual whistling or howling, and it is very uncomfortable, as well as dangerons, to sit against such crevice. Women, particularly, from this cause, as they sit much in the house, get colds in the head, rheums and defluctions, which fall into their jaws and gums, and have destroyed early many a fine set of teeth in these Northern colonies. Great and bright fires do also very much contribute to damage the eyes, dry and shrivel the skin, and bring on early the appearances of old age. In short, many of the diseases proceeding from colds, as fevers, pleurisies, &c. fatal to very great numbers of people, may be ascribed to strong drawing chimneys, whereby, in severe weather, a man is scorched before, while he is froze behind.

In both these sorts of fire-places, the greatest part of the heat from the fire is lost ; for as fire naturally darts heat every way, the back, the two jambs, and the hearth, drink up almost all that is given them, very little being reflected from bodies so dark, porous, and unpolished ; and the upright heat, which is by far the greatest, flies directly up the chimney. Thus five sixths at least of the heat (and consequently of the fewel) is wasted, and contributes nothing towards warming the room.

3. To remedy this, the Sieur *Gauger* gives, in his book entitled, *La Mechanique de Feu*, published in 1709, seven different constructions of the third sort of chimneys mentioned above, in which there are hollow cavities made by iron plates in the back, jambs, and hearth, through which plates the heat passing, warms the air in those cavities, which is continually coming into the room fresh and warm. The invention was very ingenious, and had many conveniencies. But the first expence, which was very great ; the intricacy of the design, and the difficulty of the execution, especially in old chimnies, discouraged the propagation of the invention ; so that there are, I suppose, very few such chimnies now in use. [The upright heat, too, was almost all lost in these, as in the common chimneys.]

4. The *Holland* iron stove, which has a flue proceeding from the top, and a small iron door opening into the room, comes next to be considerd. Its conveniencies are, that it makes a room all over warm ; for the chimney being wholly closed, except the flue of the stove, very little air is required to supply that, and

therefore not much rushes in at crevices, or at the door when it is opened. Little fewel serves, the heat being almost all saved; for it rays out almost equally from the four sides, the bottom and the top, into the room, and presently warms the air around it, which being rarified, rises to the cieling, and its place is supplied by the lower air of the room, which flows gradually towards the stove, and is there warmed, and rises in its turn, so that there is a continual circulation till all the air in the room is warmed. The air, too, is gradually changed, by the stove-door's being in the room, through which part of it is continually passing, and that makes these stoves wholsomer, or at least pleasanter than the *German* stoves, next to be spoken of.—But they have these inconveniencies. There is no sight of the fire, which is in itself a pleasant thing. One cannot conveniently make any other use of the fire but that of warming the room. When the room is warm, people not seeing the fire, are apt to forget supplying it with fuel till it is almost out, then growing cold, a great deal of wood is put in, which soon makes it too hot. The change of air is not carried on quite quick enough, so that if any smoke or ill smell happens in the room, it is a long time before it is discharged. For these reasons the *Holland* stove has not obtained much among the *English* (who love the sight of the fire) unless in some workshops, where people are obliged to sit near the windows for the light, and in such places they have been found of good use.

5. The *German* stove is like a box, one side wanting. It is composed of five iron plates screwed together, and fixed so as that you may put the fuel into it from another room, or from the outside of the house. It is a kind of oven reversed, its mouth being without, and body within the room that is to be warmed by it. This invention certainly warms a room very speedily and thoroughly with little fuel: No quantity of cold air comes in at any crevice, because there is no discharge of air which it might supply, there being no passage into the stove from the room. These are its conveniencies.—Its inconveniencies are, that people have not even so much sight or use of the fire as in the *Holland* stoves, and are, moreover, obliged to breathe the same unchanged air continually, mixed with the breath and perspiration from one another's bodies, which is very disagreeable to those who have not been accustomed to it.

To avoid the several inconveniencies, and at the same time to retain all the advantages of other fire-places, was contrived the PENNSYLVANIA FIRE-PLACE.

(To be continued.)